COMBAT--A SERIES OF ON-LINE COMPUTER PROGRAMS
FOR FORCE COST ANALYSIS

C. Teng and A. J. Tenzer

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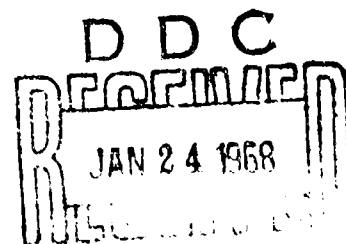
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We are here today to talk about, and illustrate, a new force
structure cost-estimating model called COMBAT. It is programmed for
an on-line computer system, and designed with the war gaming activity
in mind. COMBAT stands for cost oriented models built to analyze
trade-offs.

The term "force structure" as we shall use it simply means a
group of weapon systems aggregated into a force because they have a
common goal or mission. The term "cost model" means a mathematical
representation of the relationship between the weapons, their opera-
tions, and their estimated costs for some future time period. With
this as an introduction, let us begin by giving you some idea of the
factors which led to the development of the COMBAT cost models.

At The RAND Corporation, force structure design and analysis have
been going on for almost 20 years. A force cost model was designed
early in this period and in 1958 it was computerized. This model, and
its associated displays, is called PROM. It estimates costs for the
major Air Force missions, the weapon systems used to perform the missions,
and the resources that are involved. Costs are displayed for each

weapon system for <u>at least</u> 10 years into the future. These costs are shown by major cost category [Research, Development, Test, and Evaluation (RDT&E); Initial Investment; and Annual Operating.] PROM has provided Air Force planners with an ability to examine and compare alternative force postures in terms not only of the total resources required for a given force but also in terms of the year-by-year incremental funding requirement for each force. Many of the PROM concepts were incorporated by Charles Hitch into the new planning/programming/budgeting process for the Office of the Secretary of Defense, which was implemented in 1961. Planning, Programming, and Budgeting Systems (PPBS) are no longer unique to the defense agencies. They are becoming an increasingly important management tool for other federal agencies as well as for some state and local agencies. Computer technology must, of course, be given much of the credit for the interest in this system.

A few years ago, a new step forward was made at RAND which simplified and expanded the use of our computers. It was called JOSS,* which stands for Johnniac Open Shop System. It is an on-line sharing system which provides the analyst with an input-output typewriter with which he can communicate directly with our PDP-6 computer. No longer must the analyst worry about input sheets to be filled out, cards to be key punched, or queuing up to get on the computer. A wide variety of new programs have been designed and used at RAND to take advantage of this new system.

One particular group of programs has been designed as part of a new strategic war game. Here, we attempt to analyze the highest level decision processes in a "controlled" general war. Of major importance in the gaming is the technological performance of the weapons systems on both sides, and the decisions made with respect to the type of force structure selected. As the cost analysts in this project, we were asked to come up with a method of providing the effect, on cost, of such changes in force structure design as may be suggested <u>during</u> the the play of the game. Such changes might have to do with the design

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*JOSS is the trademark and service mark of the RAND Corporation for its computer program and services using that program.

of the weapons, their operations, or with changes in force levels.
What was needed was described to us as an "Instant PROM," and this is
the need we have attempted to satisfy.

Before talking specifically about COMBAT--how it is constructed,
and how it works--let us first describe briefly two conceptual approaches
to the design and analysis of force postures.

The first approach is called the Fixed-Effectiveness approach.
Given a level of effectiveness in the achievement of a specified goal,
an analysis is made to determine which alternative is likely to achieve
the goal at the least cost.

The second approach is called the Fixed-Cost approach. Given a
level of cost to be used to achieve some given objective, an analysis
is made to determine which alternative is likely to achieve the highest
effectiveness for the given cost.

Either or both of these approaches may be used, and it is in the
analysis of possible trade-offs between force design and cost that the
COMBAT model can be most effectively used. COMBAT permits an immediate
answer to the questions frequently asked by the planner or war gamer,
namely: "How is the cost affected if I change the equipment design,
operational mode of the system, force level, or force mix that I have
selected?"

Using COMBAT, the answers to such questions can be presented
quickly and within the context of a total force structure, the cost
implications of which are spelled out in a year-by-year fashion over
the relevant period of interest.

Let us now turn to an explanation of what the COMBAT models are.
COMBAT is composed of five individual weapon system cost-estimating
models and a time-phasing force cost-estimating model. These models
are stored in a disc file and can be recalled using remote consoles
tied into the on-line computer.

The five individual weapon system models have been designed to
estimate the total system cost of the following kinds of weapon
systems:

1. Aircraft systems
2. Missile systems
3. Ground Systems
4. Ship systems
5. Space systems

The programs were developed using the usual RAND cost-estimating
techniques and inputs, which, in general, describe the weapon systems
in terms of operations, resources, and costs. The inputs required to
estimate the cost of an aircraft weapon system would typically require
the following kinds of information:

1. The number of aircraft, payloads, and associated
   equipment per squadron.
2. Personnel estimates for the various major functions,
   that is, operations, maintenance, and support.
3. Activity rate, that is, flying hours per aircraft per
   year.
4. The cost-quantity relationships for the major hardware
   items in the weapon system.
5. The cost factors for estimating other procurement items,
   such as, spares, AGE, and facility.
6. The cost factors for estimating recurring costs of
   operations, maintenance, and support.

The outputs of these models are presented as static costs, that
is, without reference to time. Such static cost estimates can be
used throughout a study to analyze the effect on total system cost of
possible changes in equipment design and in operational design of the
weapon system. The speed with which the computer can function permits
many variations to be examined, in an iterative fashion, and within a
short period of time.

The force structure cost-estimating model, which presents costs
in a year-by-year fashion, operates in the following manner:

1. The year-by-year costs of a "base case" are put into
   the model. (We shall discuss what we mean by a base
   case later.)
2. Any relevant cost reductions are put in also on a year-
   by-year basis. These reflect any phase-outs we may wish
   to make from the base case force structure.

3. The force structures for new weapon systems and their
   estimated costs (which are obtained from the individual
   weapon system models) are then put into the force cost
   model in the following sequence:

   First, the force structure inputs, that is, the
   number of weapon system units which will be found in the
   inventory each year, are put into the model.

   Next, the RDT&E cost estimates for each new weapon
   system and the number of years necessary to complete
   each RDT&E program are put in.

   Then, the initial investment cost estimates for the
   new forces which will eventually be brought into the
   inventory are put in.

   Finally, the annual operating cost estimate for
   each new weapon system is put in.

The output format for the force structure cost-estimating model
provides time-phased costs for each new weapon system added to the
base case. These new costs are shown by major cost category (RDT&E,
Initial Investment, and Annual Operating).

This finishes the background description of why the on-line computer
program called COMBAT was developed. We hope we have given you some
idea of how it is structured and where we think it can be used in the
analyses for military decisions.

COST ANALYSIS EXAMPLE

To illustrate in a little more detail the use of the individual
weapon system models, let us pose a situation which may be resolved
with the help of the aircraft cost model. Let us assume that during
a war game we have $6 billion to develop, purchase, and operate (for
5 years) an advanced manned bomber fleet. Let us further assume that
only one design is available to us, and that we can buy and operate 125
of these aircraft for our $6 billion. Further, we discover that our 125 ai
aircraft are not able to perform the mission we assigned to them. The
problem then is: given our $6 billion limitation, how can we redesign

the aircraft weapon system to perform the mission we have assigned to
it? As we are sure you all understand, we can change either the major
design characteristics of the aircraft itself (such as speed, range,
weight, payload, etc.) or the mode of operating the system, such as
the number of flying hours, the alert posture, or the deployment scheme.
We can also look at changes in both aircraft design and operations in
various combinations.

Figure 1 presents the total system cost (RDT&E, Initial Investment,
plus 5 years of Annual Operating) of our original advanced bomber for
various force sizes. Figure 2 presents a comparison of the costs of
this system--with two alternatively designed aircraft systems in which
we have reduced the speed and size of the aircraft. We can see that
we can increase the number of aircraft in our force by redesigning the
aircraft. We would then analyze the effect of reducing the weight or
speed in terms of how well this new larger-sized bomber fleet would
perform the mission. Such an analysis might result in the conclusion
that a smaller fleet of more expensive aircraft is what we really need
to satisfy our needs or that part of the mission has to be assigned to
another weapon system in our force.

Figure 3 shows the effect of change in the operations of the air-
craft weapon system on total system cost. Here we can see that by
making changes in the mode of operations (assuming we have elected to
stay with aircraft Design A), we can get additional aircraft by going
to operational mode 2 and even more by operating in mode 3. Again, at
this point we don't know how effective the larger forces would be in
performing the mission.

To produce the bomber cost estimates in Figs. 1-3, we would use
the aircraft individual weapon system model. A flow diagram for this
model is shown in Fig. 4. Figure 5 presents the input documentation
sheets which we would use to record the inputs for each set of cost
estimates. A blank output format for the aircraft cost model is
identified as Fig. 6. This output reflects the 5-year system cost for
a force of 210 aircraft.

Figure 1

FORCE SIZE VS SYSTEM COST

AIRCRAFT DESIGN "A"

TOTAL SYSTEM COST

NUMBER OF UE AIRCRAFT
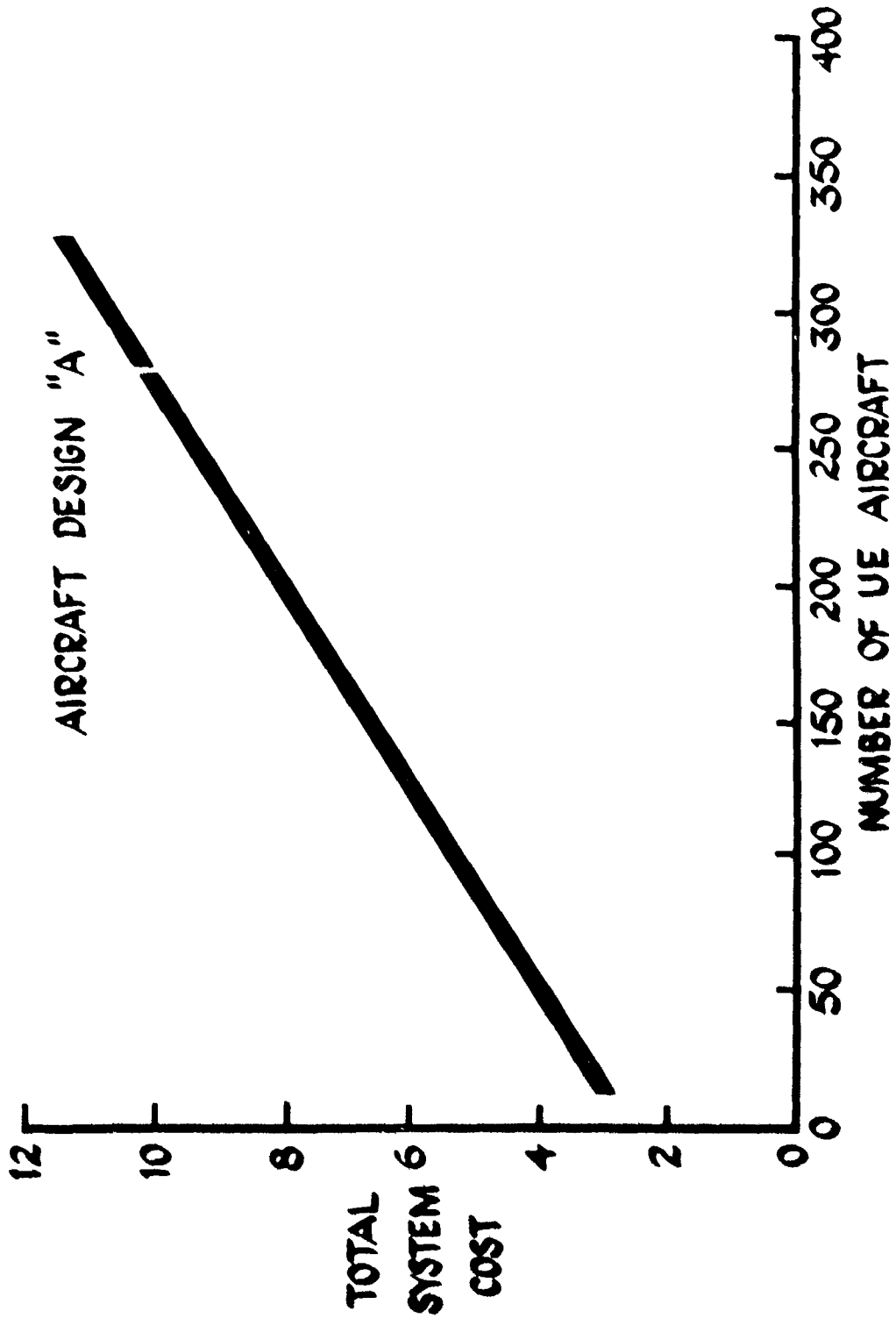
Figure 2

FORCE SIZE VS SYSTEM COST

AIRCRAFT DESIGN "A"

AIRCRAFT DESIGN "B"

AIRCRAFT DESIGN "C"

TOTAL SYSTEM COST

NUMBER OF UE AIRCRAFT
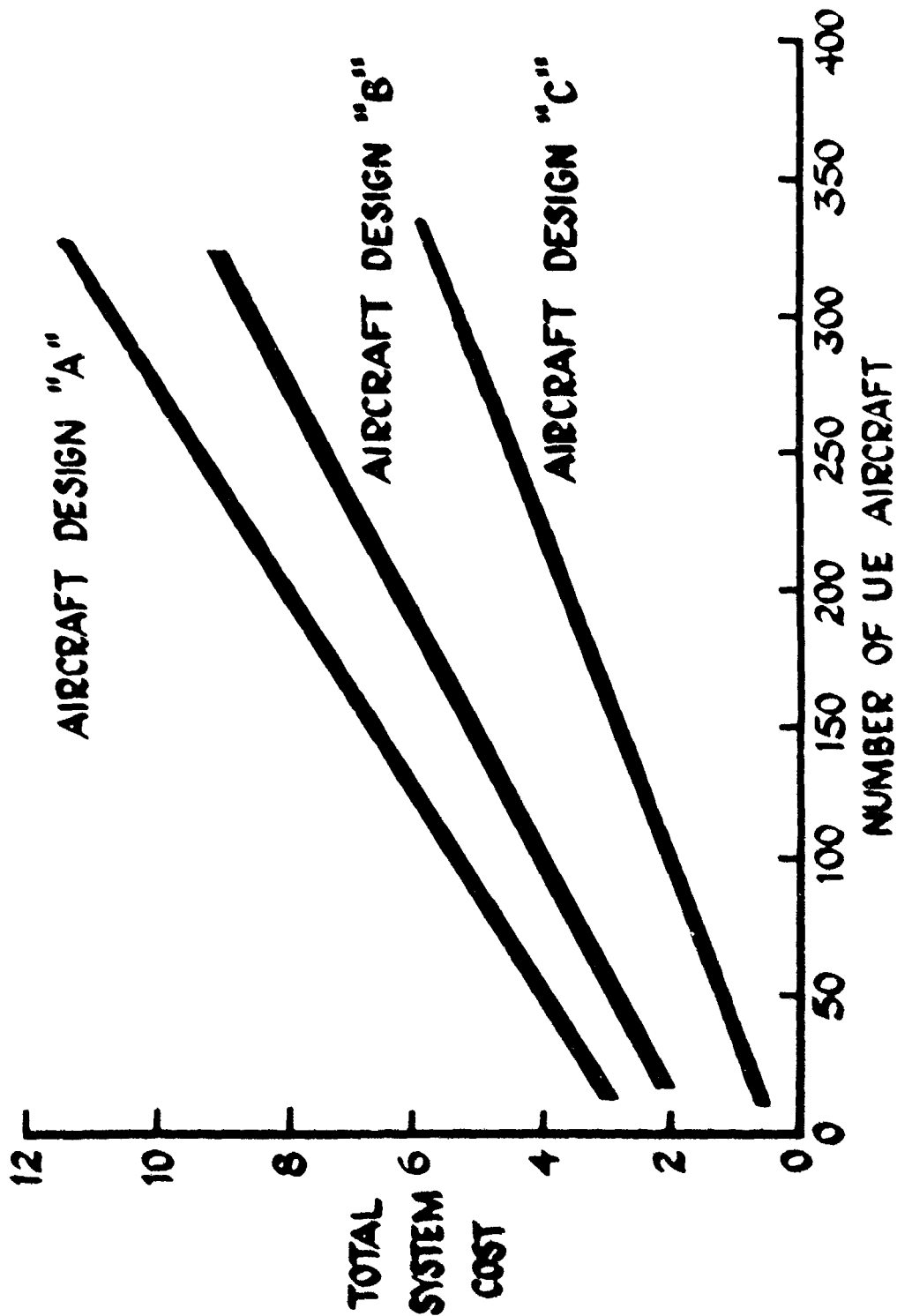
Figure 3

FORCE SIZE VS SYSTEM COST

Figure 4

ACMOD

RECALL ACMOD

CONTINUOUS AIRBORNE ALERT

YES → AIRCRAFT SYSTEM INPUTS

NO → AIRCRAFT SYSTEM INPUTS

ROT & E COST THRU-PUTS

AIRCRAFT CALC.
1. QUANTITY REQ.
2. INITIAL INV. COST

PAYLOAD CALC.
1. QUANTITY REQ.
2. INITIAL INV. COST

SPEC AVIONICS CALC.
1. QUANTITY REQ.
2. INITIAL INV. COST

OTHER INITIAL INVESTMENT COST CALC.

AIRCRAFT: INITIAL SPARES AND AGE

PAYLOAD: INITIAL SPARES AND AGE

SPEC AVIONICS INITIAL SPARES AND AGE

TOTAL: INITIAL INVESTMENT COST

WARHEAD

PERSONNEL

OTHER

MAINT: PAYLOAD & PAYLOAD AGE

MAINT: SP. AVIONICS & SP. AVIONICS AGE

MAINT: AIRCRAFT & AIRCRAFT AGE

TOTAL: ANNUAL OPERATING COSTS

PERSONNEL

AIRCRAFT POL

OTHER

AIRCRAFT SYSTEM COST PRINTOUT

Figure 5
ACMOD

AIRCRAFT MODEL

INPUT DOCUMENTATION SHEET

Y =			Number of Years
U =			UE per squadron
y(1) =			Endurance of aircraft
y(2) =			Reserve flying hour per flight
y(3) =			Flying time from base to station
y(4) =			Length of periodic in hours
y(5) =			Flying hours per periodic inspection
y(6) =			Length of post-flight in hours
y(7) =			Flying hours per post-flight inspection
y(8) =			Percentage of unscheduled maintenance (hours)
y(9) =			Percentage of unscheduled maintenance (sorties)
y(10)=			Preflight, servicing, debriefing, etc., hours
y(11)=			Extra down-time per sortie in hours
y(12)=			Length of maintenance shift in hours
y(13)=			Number of shifts per day
y(14)=			Number of stations per system
y(15)=			Number of aircraft per station
S =			Number of squadrons
B =			Other aircraft per squadron (command support & attrition)
F =			FH/sqn/yr
Z =			Payload per squadron (0 if none)
R =	$	x10^6	RDT&E cost (in millions)
P(1) =			Number of operating personnel per squadron
P(2) =			Number of maintenance personnel per squadron
P(3) =			Number of support personnel per squadron
P(4) =		%	Additional support personnel--% of O&M personnel
C(1) =	$	x10^6	Cost of aircraft theoretical unit 1 (in millions)
L(1) =		%	Aircraft procurement learning slope (cumulative average)
Q(1) =			Procurement level--aircraft
W(1) =	$	x10^6	Cost per warhead (in millions)
D(1) =			Number of warheads per squadron
C(2) =	$	x10^6	Cost of payload theoretical unit 1 (in millions)
L(2) =		%	Payload procurement learning slope (cumulative average)
Q(2) =			Procurement level--payload
C(3) =	$	x10^6	Cost of spec avionics pkg theoretical unit 1 (millions)

The label **For peacetime airborne patrol** is written vertically along the left side spanning rows y(1) through y(15).

Figure 5--Continued
ACMOD AIRCRAFT MODEL--Continued

L(3) =		%	Spec avionics pkg procurement learning slope (cum avg)
Q(3) =			Procurement level--spec avionics pkg
C(4) =		%	Initial investment support--aircraft spares (% of A/C proc cost)
C(5) =		%	Initial investment support--aircraft AGE (% of A/C proc cost)
C(6) =		%	Initial investment support--payload spares (% of payload proc cost)
C(7) =		%	Initial investment support--payload AGE (% of payload proc cost)
C(8) =		%	Initial investment support--spec avionics pkg spares (% of spec avionics pkg proc cost)
C(9) =		%	Initial investment support--spec avionics pkg AGE (% of spec avionics pkg proc cost)
C(10)=	$	$\times 10^6$	Initial investment other cost per squadron (in millions)
C(11)=	$		Initial investment other cost per personnel
A(1) =		%	Direct maintenance cost--payload (% of payload proc cost)
A(2) =		%	Direct maintenance cost--payload AGE (% of payload AGE proc cost)
A(3) =		%	Direct maintenance cost--spec avionics pkg (% of spec avionics pkg proc cost)
A(4) =		%	Direct maintenance cost--spec avionics pkg AGE (% of spec avionics pkg proc cost)
A(5) =	$		POL cost per flying hour
A(6) =	$		Direct aircraft maintenance cost ($/FH)
A(7) =		%	Direct maintenance cost--aircraft AGE (% of aircraft AGE proc cost)
A(8) =		%	Modification and replacement cost per year (% of aircraft proc cost)
A(9) =	$		Op personnel pay and allowance and replacement training cost ($/op personnel)
A(10)=	$		Support personnel pay and allowance and replacement training cost ($/support personnel)
A(11)=	$		Other personnel cost ($/personnel)
A(12)=	$		Other squadron cost ($/squadron)

Figure 6

OUTPUT FORMAT FOR AIRCRAFT WEAPON SYSTEM COST MODEL

Aircraft System

5 YEARS SYSTEM COSTS
($ million)

RDT&E =
Initial Inv =
Warheads =
Annual Op (5 yrs) =

TOTAL =

Number of squadrons   UE per squadron   FH/sqn/yr
Payload per squadron   Payload proc cost $ (millions)

Total aircraft proc.   Total aircraft proc. cost $ (millions)

Total Personnel
Oper. Pers   Maint Pers   Support Pers

Warhead Qty. (Total)   Warhead cost (Total) $ (millions)

It is possible to analyze the cost impact of many variations and combinations of the foregoing types of cost sensitive design and operational parameters. The on-line computer permits it to be done quickly and in an iterative fashion so that the results can be used as part of the war gaming deliberations and analysis. The total time needed to generate the cost estimates shown in Figs. 1-3 would be about 10 minutes, assuming that the estimating factors were available.

In a similar fashion, the time-phased force cost-estimating model can be used to analyze various force mixes of the five categories of weapon systems. This has been previously mentioned. Now we can examine the impact on cost (over time) of various phase-in options.

Previously, we mentioned a base case, which refers, in essence, to an attempt to establish a point of origin in order to carry out a comparative analysis. For the current example, let us assume that the base case consists of the total DOD strategic forces as presented in Program I of the DOD 5-Year Force and Financial Plan. An unclassified representation of this program structure is shown in Fig. 7. It includes forces of the three major services involved in both the strategic offense and continental defense missions. Also included in the total program are support force elements as well as the tactical force elements. We have shown the forces as if no new decisions will be made in the future. This is called a "spend-out" assumption and the cost impact of this assumption is shown graphically in Fig. 8. The base case, and its estimated cost over time, is the benchmark from which our new force structures are developed, costed, and compared.

To continue with our example, let us assume that we do make some new decision--specifically, that we are going to add some new offensive and defensive capability as shown in Fig. 9. As you can see, all of this new capability is phased into our force posture during 1975. The year-by-year cost of this new force (Variation A) is shown in Fig. 10.

If for some reason, the large peak of funds required in 1973 appears infeasible or undesirable, we can examine alternative phase-in schedules. Two such alternatives (Variations B and C) appear in Fig. 11.

STRATEGIC WAR FORCES UNITS & COSTS
(ILLUSTRATIVE BASE CASE)

	NUMBER OF OPERATING FORCE UNITS													TOA BILLIONS (1967 DOLLARS)										
	68	69	70	71	72	73	74	75	76	77	78	79	80	68	69	70	71	72	73	74	75	76	77	78
USAF																								
STRATEGIC AIRCRAFT																								
BOMBERS	600	550	550	500	500	500	500	500	400	400	400	400	400	1.1	1.2	1.2	.5	.5	.5	.5	.5	.5	.4	.4
AIR TO SURFACE MISSILES	200	200	200	500	500	500	500	500	500	500	500			.2	.3	.3	.2	.2	.1	.1	.1	.1	.1	.1
TANKER	500	500	500	500	500	500	500	500	500	500	500	500	500	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
STRATEGIC RECON	50	50	50	50	50	50	50	50	50	50	50	50	50	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
STRATEGIC MISSILES	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1.4	1.1	.8	.5	.3	.3	.3	.3	.3	.2	.2
CMD, CONTROL & COMM														.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
SUPPORT SAC														.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6
ADV FLYING TNG																								
HQ SAC																								
BASE OPERATIONS																								
AIRCRAFT DEFENSE	400	400	350	350	350	300	300	300	250	250	200	200	150	.2	.2	.2	.2	.2	.2	.1	.1	.1	.1	.1
CMD, CONTROL & COMM														.8	.7	.6	.6	.6	.5	.5	.5	.5	.5	.5
SUPPORT ADC														.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
ADV FLYING TNG																								
HQ ADC																								
BASE OPERATIONS																								
U.S.N.																								
STRATEGIC SUB MSL	500	500	500	500	500	500	500	500	500	500	500	500	500	1.0	1.0	.8	.8	.8	.8	.8	.8	.8	.8	.8
HQ & HQ SUPPORT																								
U.S. ARMY																								
SURFACE TO AIR MISSILES	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
CMD, CONTROL & COMM																								
HQ & HQ SUPPORT																								
BASE OPERATION																								
GRAND TOTAL														6.3	6.1	5.5	4.4	4.2	4.0	3.9	3.9	3.9	3.8	3.8

Figure 8

TOA BY YEARS
BASE CASE FORCE STRUCTURE
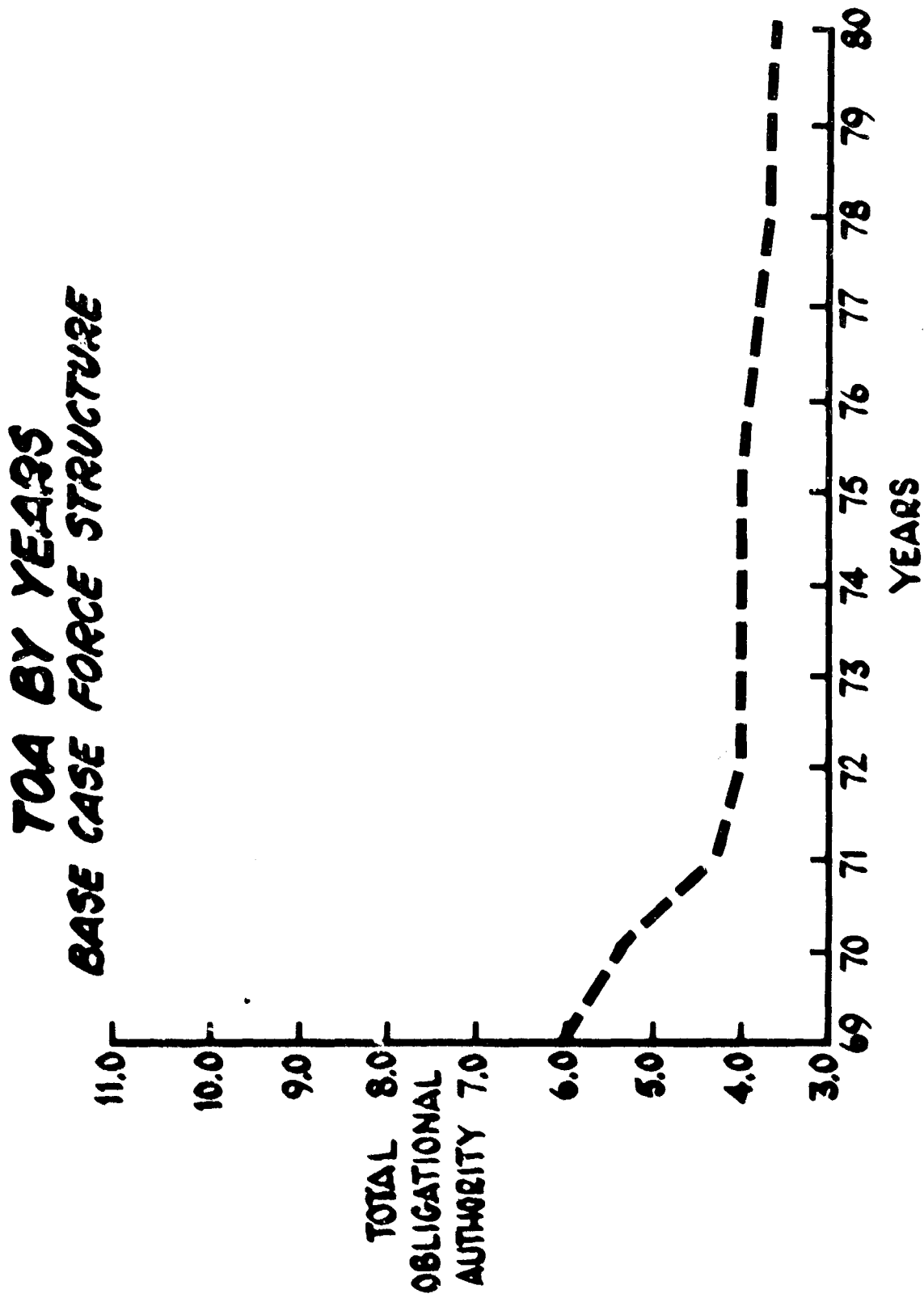
Figure 9

FORCE VARIATIONS

FISCAL YEAR

NEW SYSTEMS

	69	70	71	72	73	74	75	76	77	78	79	80
BOMBER SQS	-	-	-	-	-	-	9	9	9	9	9	9
MISSILES SQS	-	-	-	-	-	-	10	10	10	10	10	10
DEFENSE	-	-	-	-	-	-	100	100	100	100	100	100

VARIATION "A"
1975

Figure 10

TOA BY YEARS
BASE CASE & VARIATIONS
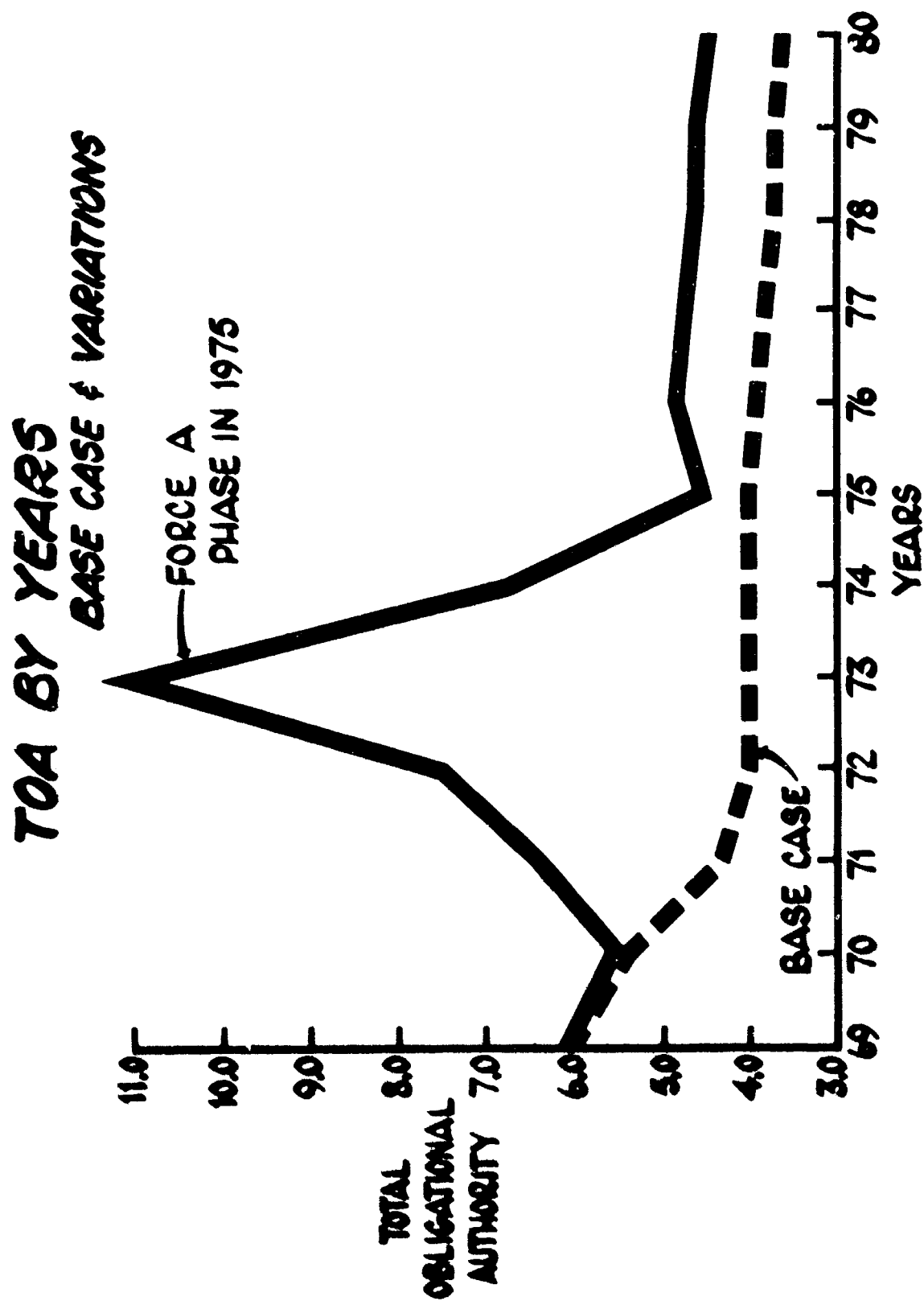
Figure 11

FORCE VARIATIONS

FISCAL YEAR

NEW SYSTEMS

VARIATION "B"
1974-1977

	69	70	71	72	73	74	75	76	77	78	79	80
BOMBER SQS	-	-	-	-	-	-	2	5	7	9	9	9
MISSILES SQS	-	-	-	-	-	-	2	4	7	10	10	10
DEFENSE	-	-	-	-	-	25	40	60	75	90	100	100

VARIATION "C"
1974-1980

	69	70	71	72	73	74	75	76	77	78	79	80
BOMBER SQS	-	-	-	-	-	-	1	3	5	7	9	9
MISSILES SQS	-	-	-	-	-	-	1	2	3	5	7	10
DEFENSE	-	-	-	-	-	25	40	60	75	90	100	100

In Variation B, the new capability would be phased in by stages between 1974 and 1977; in Variation C, in stages between 1974 and 1980. The effects of these alternative phase-in options on the year-by-year costs can be seen in Fig. 12.

As in the previous example, we are only dealing with the effects on costs of changes in force design alternatives. It would take about 10 minutes to estimate year-by-year costs of each force variation using the on-line computer and the COMBAT force structure cost model.

Figure 13 presents a summary flow diagram for the COMBAT force structure time-phasing model. Figure 14 presents the input documentation sheet we would use to record the inputs for each force variation. Figure 15 presents a sample format for the base case and for Variation C.

CONCLUSIONS

We have illustrated the kinds of costs that the new COMBAT model has been designed to estimate. These kinds of estimates have been made in the past. With COMBAT, however, they can be made quickly using an on-line computer system. We feel this quick response capability can provide a new dimension to the analysis of force-oriented issues. A group of military analysts or war gamers can use this capability to examine the cost impact of force posture changes in an iterative fashion in a relatively short period of time.
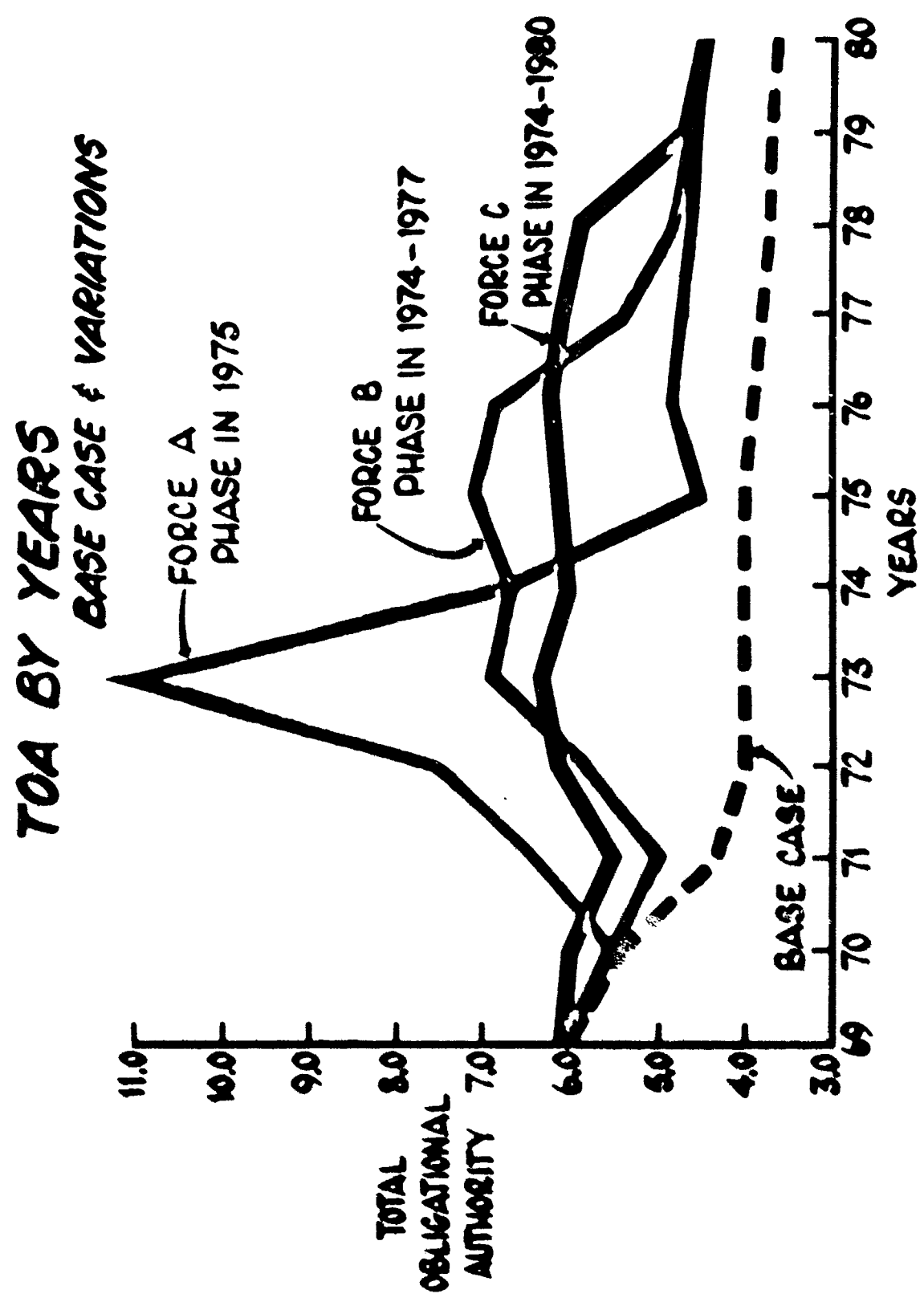
Figure 12

TOA BY YEARS
BASE CASE & VARIATIONS

Figure 13

COMBAT

FORCE STRUCTURE TIME PHASING MODEL
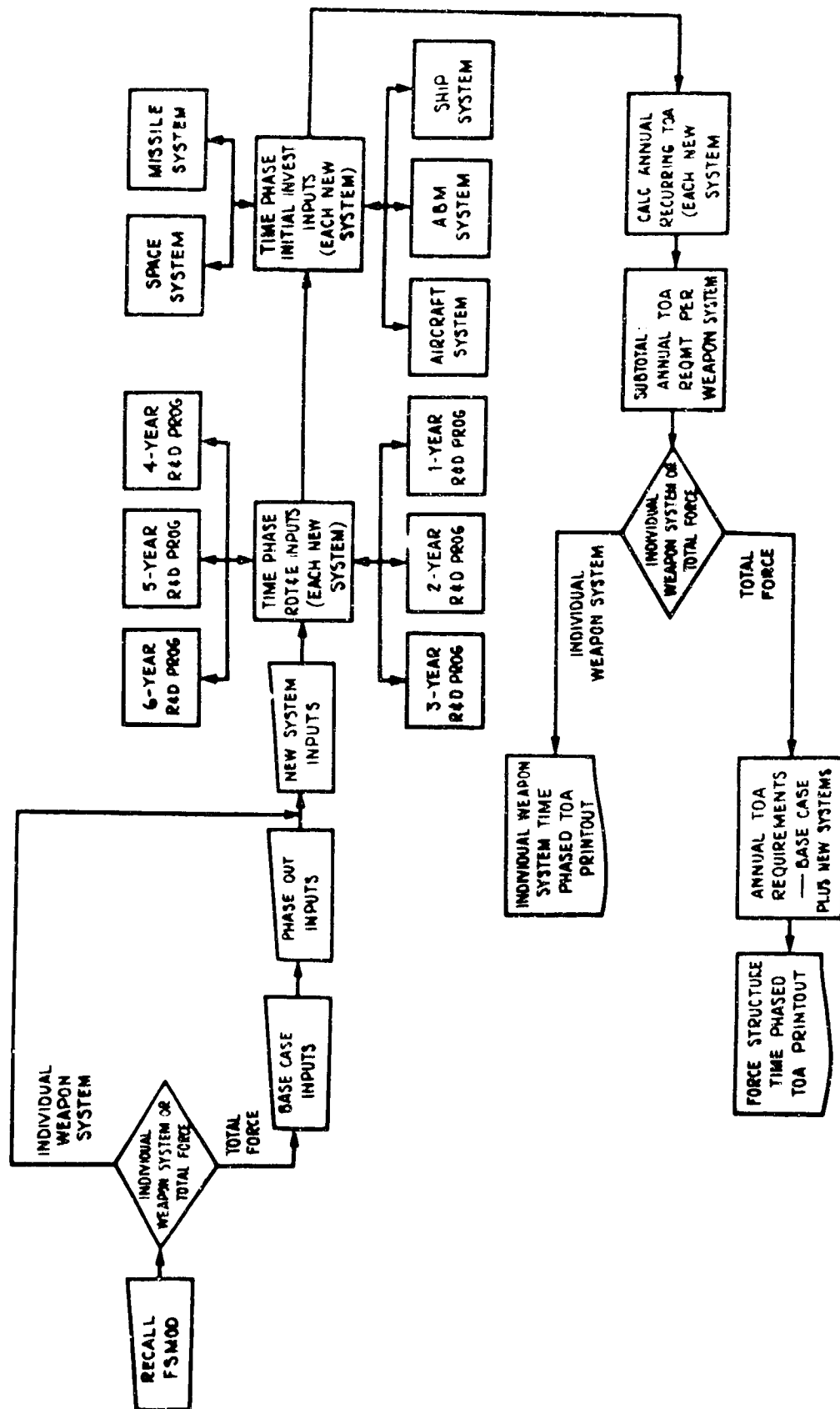
Fig. 14--FSMOD

Force Structure Time Phasing Model

Input Documentation Sheet

J	=			$J = 1$ for total force structure (including base case) time phasing; $J = 2$ for individual weapon system time phasing.
Base Case Inputs B(-7)	=	$	$\times 10^9$	Base Case Inputs (billions) -- year N-7
B(-6)	=	$	$\times 10^9$	year N-6
B(-5)	=	$	$\times 10^9$	year N-5
B(3)	=	$	$\times 10^9$	year N+3
B(4)	=	$	$\times 10^9$	year N+4
a	=			$a = 1$ for phaseouts; 0 for no phaseouts.
Phase Out Inputs P(-7)	=	$	$\times 10^9$	Phaseout inputs (billions) -- year N-7
P(-6)	=	$	$\times 10^9$	year N-6
P(-5)	=	$	$\times 10^9$	year N-5
P(3)	=	$	$\times 10^9$	year N+3
P(4)	=	$	$\times 10^9$	year N+4
n				Number of new weapon systems to be time phased.
New System Inputs (Repeat n times) W(i)	=			Weapon system identification code for weapon system No. i (three digits) 1xx = aircraft 2xx = missile 3xx = ABM 4xx = ground electronics 5xx = space 6xx = ship
V(i)	=			ue aircraft or missile per squadron if W/S No. i is an aircraft or missile system; 1 if W/S No. i is a ship or satellite system; 100 if W/S No. i is an ABM system.
I(i)	=	$	$\times 10^6$	Total initial investment cost for W/S No. i (in millions)
D(i)	=			IOC date for W/S No. i.
u(i)	=			Maximum number of missile/aircraft squadrons, ships, satellites or percent of ABM or ground electronic system operational during year N-7 to N+4 for W/S No. i.

Fig. 14--continued

Y(1) =		yrs.	Years to complete R&D program for W/S No. 1.
R(1) =	$	x10^6	Total R&D program cost beginning year N-7 for W/S No. 1 (in millions).
O(1) =	$	x10^6	Annual operating cost per aircraft/missile squadron, ship, satellite or 100% implemented ABM/ground electronics system for W/S No. 1 (in millions).
S(1,D(1)) =			No. of squadrons/ships/satellites or percent of ABM/ground electronics system operational in year N+D(1) for W/S No. 1.
S(1,D(1)+1)=			No. of squadrons/ships/satellites or percent of ABM/ ground electronics system operational in year N+D(1)+1 for W/S No. 1.
S(1,3) =			No. of squadrons/ships/satellites or percent of ABM/ground electronics system operational in year N+3 for W/S No. 1.
S(1,4) =			No. of squadrons/ships/satellites or percent of ABM/ ground electronics system operational in year N+4 for W/S No. 1.

Figure 15

OUTPUT FORMAT FOR BASE CASE
AND FORCE VARIATION "C"

TOTAL FORCE MODEL
Illustrative Base Case
(Billions of Dollars)

w/s	UE/ sqn	yrs R D	N-7	N-6	N-5	N-4	N-3	N-2	N-1	N	N+1	N+2	N+3	N+4
Base Case			6.1	5.4	4.3	4.0	4.0	4.0	4.0	3.9	3.8	3.7	3.7	3.6

Figure 15--continued

Annual Operating Costs (TOA)
(millions of dollars)

w/s	UE/ sqn	yrs R D	N-7	N-6	N-5	N-4	N-3	N-2	N-1	N	N+1	N+2	N+3	N+4
111	30	2	0	0	0	0	0	0	22	89	178	267	356	400
311	100	3	0	0	0	0	0	63	163	250	338	413	475	500
211	50	4	0	0	0	0	0	0	0	0	0	0	0	0

New Systems Costs (TOA)
(millions of dollars)

w/s	UE/ sqn	yrs R D	N-7	N-6	N-5	N-4	N-3	N-2	N-1	N	N+1	N+2	N+3	N+4
111	30	2	0	0	0	500	600	322	467	533	622	511	356	400
sub-total			0	0	0	500	600	322	467	533	622	511	356	400
311	100	3	0	563	1038	1315	1260	1218	1178	933	705	518	475	500
sub-total			0	563	1038	1815	1860	1540	1644	1466	1327	1029	831	900
211	50	4	0	50	175	245	458	450	495	833	945	1148	203	0
sub-total			0	613	1213	2060	2318	1990	2139	2298	2272	2176	1033	900

Base Case + New systems (TOA)
(Billions of Dollars)

w/s	UE/ sqn	yrs R D	N-7	N-6	N-5	N-4	N-3	N-2	N-1	N	N+1	N+2	N+3	N+4
Base Case			6.1	5.4	4.3	4.0	4.0	4.0	4.0	3.9	3.8	3.7	3.7	3.6
New Systems			.0	.6	1.2	2.1	2.3	2.0	2.1	2.3	2.3	2.2	1.0	.9
Phase Outs			.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Total			6.1	6.0	5.5	6.1	6.3	6.0	6.1	6.2	6.1	5.9	4.7	4.5

Figure 15--continued

New Systems

Total Operational Squadrons/Ships/Sites

w/s	UE/ sqn	yrs R D	N-7	N-6	N-5	N-4	N-3	N-2	N-1	N	N+1	N+2	N+3	N+4
111	30	2	0	0	0	0	0	0	1	3	5	7	9	9
311	100	3	0	0	0	0	0	25	40	60	75	90	100	100
211	50	4	0	0	0	0	0	0	1	2	3	5	7	10

Research and Development Costs (TOA)
(millions of dollars)

w/s	UE/ sqn	yrs R D	N-7	N-6	N-5	N-4	N-3	N-2	N-1	N	N+1	N+2	N+3	N+4
111	30	2				500	500							
311	100	3		125	250	125								
211	50	4		50	175	200	75							

Initial Investment (TOA)
(millions of dollars)

w/s	UE/ sqn	yrs R D	N-7	N-6	N-5	N-4	N-3	N-2	N-1	N	N+1	N+2	N+3	N+4
111	30	2	0	0	0	0	100	322	444	444	444	244	0	0
311	100	3	0	438	788	1190	1260	1155	1015	683	368	105	0	0
211	50	4	0	0	0	45	383	450	495	833	945	1148	203	0